(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **09180907 A**

(43) Date of publication of application: **11.07.97**

(51) Int. Cl **H01C 7/02**
**C04B 35/46**
**H01C 1/14**
**H01C 7/04**
**H01C 7/18**

(21) Application number: **08273667**

(22) Date of filing: **16.10.96**

(30) Priority: **27.10.95 JP 07280779**

(71) Applicant: **MURATA MFG CO LTD**

(72) Inventor: **NIIMI HIDEAKI**

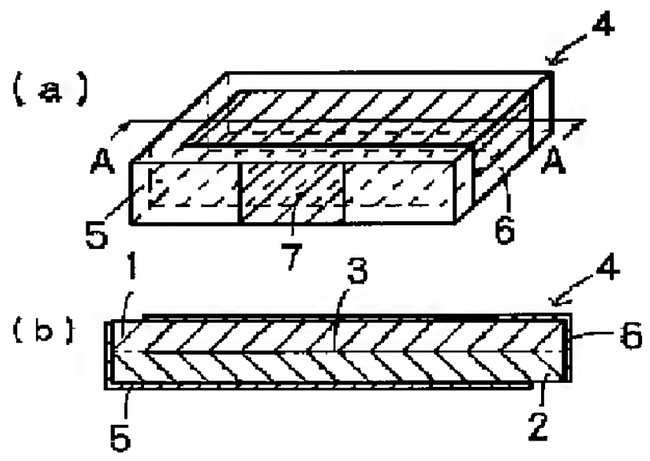
# (54) MULTILAYERED COMPOSITE CERAMIC AND MULTILAYERED COMPOSITE CERAMIC DEVICE



(57) Abstract:

PROBLEM TO BE SOLVED: To provide a multilayered composite ceramic made of a PTC (a semiconductor exhibiting a positive temperature characteristic of resistance) ceramic device, an NTC ceramic device or a fixed resistance ceramic device, and an electrode which are integrated and a multilayered composite ceramic device.

SOLUTION: A multilayered composite ceramic device 2 consists of a multilayered ceramic body made of a PTC ceramic device 2 and an NTC ceramic device or a fixed resistance ceramic device 1 which are integrated. The PTC ceramic device 2 consists of a PTC ceramic whose major constituent is barium titanate. The NTC ceramic device or the fixed resistance ceramic device 1 consists of an NTC-R ceramic whose major constituent is barium titanate. A multilayered composite ceramic device 4 provided with an inner electrode 3 in a multilayered ceramic body made of at least the PTC ceramic device 2 and the NTC ceramic device or the fixed resistance ceramic device 1 which are integrated.



# JP 09-180907 A

(11)Publication number : 09-180907 (51)Int.Cl. H01C 7/02
(43)Date of publication of application : 11.07.1997
(21)Application number : 08-273667 (71)Applicant :MURATA MFG CO LTD
(22)Date of filing : 16.10.1996 (72)Inventor : NIIMI HIDEAKI

(30)Priority
Priority number : 07280779 Priority date : 27.10.1995 Priority country : JP

(54) **MULTILAYERED COMPOSITE CERAMIC AND MULTILAYERED COMPOSITE CERAMIC DEVICE**

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a multilayered composite ceramic made of a PTC (a semiconductor exhibiting a positive temperature characteristic of resistance) ceramic device, an NTC ceramic device or a fixed resistance ceramic device, and an electrode which are integrated and a multilayered composite ceramic device.
SOLUTION: A multilayered composite ceramic device 2 consists of a multilayered ceramic body made of a PTC ceramic device 2 and an NTC ceramic device or a fixed resistance ceramic device 1 which are integrated. The PTC ceramic device 2 consists of a PTC ceramic whose major constituent is barium titanate. The NTC ceramic device or the fixed resistance ceramic device 1 consists of an NTC-R ceramic whose major constituent is barium titanate. A multilayered composite ceramic device 4 provided with an inner electrode 3 in a multilayered ceramic body made of at least the PTC ceramic device 2 and the NTC ceramic device or the fixed resistance ceramic device 1 which are integrated.

CLAIMS

[Claim(s)]
[Claim 1]A PTC ceramic device, a NTC ceramic device, or a fixed-resistance ceramic device consists of a lamination ceramic body by which laminate integration was carried out, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, Lamination compound ceramics having an internal electrode inside a lamination ceramic body with which said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device was united at least.
[Claim 2]The lamination compound ceramics according to claim 1 to which, as for a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, a mole ratio (Ba/Ti) of barium and titanium is characterized by being 0.99-1.05.
[Claim 3]Lamination compound ceramics given in either of claim 1 or 2 to which, as for a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, 5-25-mol% of barium is characterized by being replaced by calcium.
[Claim 4]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device, The lamination compound ceramics according to claim 1, wherein mole ratios (Ba/Ti) of barium and titanium are 0.95-1.01.
[Claim 5]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device, converting manganese oxide into Mn -- 0.01-1-mol % -- lamination compound ceramics given in either of containing claim 1 or 4.
[Claim 6]A ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, Or a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or a ceramic resistor which uses as the main ingredients barium titanate which constitutes said fixed-resistance ceramic device -- SiO 20.05-5-mol % -- lamination compound ceramics given in either of containing claim 1, 2, 3, 4, or 5.
[Claim 7]A PTC ceramic device, a NTC ceramic device, or a fixed-resistance ceramic device is a lamination compound ceramic device which consists of circuitry by which the series connection was carried out equivalent, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, Said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device consists of a lamination ceramic body by which laminate integration was carried

out, and in the surface of said lamination ceramic body. The 1st electrode for said PTC ceramic devices, and the 2nd electrode said object for NTC ceramic devices, or for said fixed-resistance ceramic devices, And a lamination compound ceramic device, wherein the 3rd electrode electrically connected with an internal electrode formed between said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device is formed.
[Claim 8]The series connection of a PTC ceramic device, a NTC ceramic device, or the fixed-resistance ceramic device is carried out, It is the lamination compound ceramic device provided with a circuit where a bipolar electrode is drawn from an intermediate junction with said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, Said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device consists of a lamination ceramic body by which laminate integration was carried out, In a field of said PTC ceramic device, the 1st side of said lamination ceramic body, An internal electrode connected to exterior electrodes formed in the 2nd side is formed, respectively, and an internal electrode connected to exterior electrodes formed in said 2nd side of said lamination ceramic body is formed in a field of said NTC ceramic device or said fixed-resistance ceramic device, Between a field of said NTC ceramic device or said fixed-resistance ceramic device, or said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device, An internal electrode connected to exterior electrodes formed in the 3rd side of said lamination ceramic body is formed, A lamination compound ceramic device, wherein exterior electrodes formed in said 2nd side of said lamination ceramic body are bipolar electrodes of a series connection circuit with said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device.

[Claim 9]A lamination compound ceramic device given in either of claim 7 or 8 to which, as for a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, a mole ratio (Ba/Ti) of barium and titanium is characterized by being 0.99-1.05.
[Claim 10]A lamination compound ceramic device given in either of claim 7, 8, or 9 to which, as for a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, 5-25-mol% of barium is characterized by being replaced with calcium.
[Claim 11]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device, A lamination compound ceramic device given in either of claim 7 or 8, wherein mole ratios (Ba/Ti) of barium and titanium are 0.95-1.01.
[Claim 12]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device, converting manganese oxide into manganese -- 0.01-1-mol % -- a lamination compound ceramic device given in either of containing claim 7, 8, or 11.

[Claim 13]A ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device, Or a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients

barium titanate which constitutes said NTC ceramic device, or a ceramic resistor which uses as the main ingredients barium titanate which constitutes said fixed-resistance ceramic device -- SiO 20.05-5-mol % -- a lamination compound ceramic device given in either of containing claim 7, 8, 9, 10, 11, or 12.

---

DETAILED DESCRIPTION

---

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the lamination compound ceramic device using the lamination compound ceramics and it which unified the PTC ceramic device, the NTC ceramic device, or the fixed-resistance ceramic device.

[0002]
[Description of the Prior Art]The semiconductor ceramic (henceforth PTC ceramics) which has a positive resistance temperature characteristic has the characteristic (henceforth a PTC characteristic) which resistance increases rapidly in connection with a rise in heat above a Curie point. On the other hand, with PTC ceramics, the semiconductor ceramic (henceforth NTC ceramics) which has a negative resistance temperature characteristic conversely has the characteristic (henceforth an NTC characteristic) that resistance decreases rapidly, in connection with the rise in heat.
[0003]As a trial which unifies the element (henceforth a PTC element) which has this PTC characteristic, and the element (henceforth a NTC element) which has an NTC characteristic, there is a PTC-NTC unification element indicated to JP,4-280601,A. The PTC-NTC unification element indicated to JP,4-280601,A unites with a laminating condition the NTC element and electrode which use as the main ingredients the PTC element and V2O3 which use V2O3 as the main ingredients.

[0004]
[Problem(s) to be Solved by the Invention]The PTC-NTC unification element indicated to said JP,4-280601,A has joined the tabular electrode (henceforth an electrode) by the method of of the following (1), (2), and (3) by the product made from a PTC element, a NTC element, tungsten, or molybdenum.
(1) Carry out the silver soldering of a PTC element, a NTC element, and the electrode, and join.
(2) Really calcinate the PTC ceramic compact, NTC ceramic compact, and electrode which added metal powders, such as tungsten or molybdenum.
(3) Paste metal powders, such as tungsten or molybdenum, apply to a PTC ceramic compact, a NTC ceramic compact, and an electrode, and really calcinate.

[0005]The following problems are included in these joining methods.
[0006]In order to join in the joining method of (1) after calcinating a PTC element, a NTC element, and an electrode, the heat couplings of a PTC element and a NTC element are bad, moreover a baking process and a joining process are needed, and mass production nature is bad.
In the joining method of (2), since tungsten or molybdenum is mixed in a PTC ceramic compact and a NTC ceramic compact, a PTC characteristic and an NTC characteristic fall.
In the joining method of (2) and (3), since the coefficients of thermal expansion of an electrode, and PTC and NTC ceramics differ, an electrode, PTC, and NTC ceramics peel at the time of sintering, or excessive power is added to PTC and NTC ceramics, and a crack arises.
[0007]The junction area of a PTC element, a NTC element, and an electrode shifts easily. Since metal, such as vanadium oxide, tungsten, and molybdenum, was

special metal, material cost became high and it had been set to one of the factors which obstruct the cost cut of the whole unification element.

[0008]Each characteristic is properly demonstrated using the material which the purpose of this invention is generally cheap and is easy to supply, It is providing the lamination compound ceramic device using the lamination compound ceramics and it which solved the fault resulting from the difference of the coefficient of thermal expansion of ceramics and an electrode, and carried out laminate integration of a PTC ceramic device, a NTC ceramic device or a fixed-resistance ceramic device, and the electrode.
[0009]
[Means for Solving the Problem]An invention concerning claim 1 consists of a lamination ceramic body to which laminate integration of a PTC ceramic device, a NTC ceramic device, or the fixed-resistance ceramic device was carried out, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, They are lamination compound ceramics which have an internal electrode inside a lamination ceramic body with which said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device was united at least.
[0010]Inventions concerning claim 2 are lamination compound ceramics to which a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device sets a mole ratio (Ba/Ti) of barium and titanium to 0.99-1.05.

[0011]Inventions concerning claim 3 are lamination compound ceramics by which a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device is replaced from calcium in 5-25-mol% of barium.
[0012]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device an invention concerning claim 4, They are lamination compound ceramics which set a mole ratio (Ba/Ti) of barium and titanium to 0.95-1.01.
[0013]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device an invention concerning claim 5, converting manganese oxide into Mn -- 0.01-1-mol % -- they are contained lamination compound ceramics.
[0014]A ceramic semiconductor which has a positive resistance temperature characteristic to which an invention concerning claim 6 uses as the main ingredients barium titanate which constitutes said PTC ceramic device, Or a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or a ceramic resistor which uses as the main ingredients barium titanate which constitutes said fixed-resistance ceramic device -- SiO 20.05-5-mol % -- they are contained lamination compound ceramics.
[0015]An invention concerning claim 7 is a lamination compound ceramic device which a PTC ceramic device, a NTC ceramic device, or a fixed-resistance ceramic device turns into from circuitry by which the series connection was carried out equivalent, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium

titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, Said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device consists of a lamination ceramic body by which laminate integration was carried out, and in the surface of said lamination ceramic body. The 1st electrode for said PTC ceramic devices, and the 2nd electrode said object for NTC ceramic devices, or for said fixed-resistance ceramic devices, And it is the lamination compound ceramic device in which the 3rd electrode electrically connected with an internal electrode formed between said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device is formed.

[0016]As for an invention concerning claim 8, the series connection of a PTC ceramic device, a NTC ceramic device, or the fixed-resistance ceramic device is carried out, It is the lamination compound ceramic device provided with a circuit where a bipolar electrode is drawn from an intermediate junction with said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device, Said PTC ceramic device consists of a ceramic semiconductor which has a positive resistance temperature characteristic which uses barium titanate as the main ingredients, Said NTC ceramic device consists of a ceramic semiconductor which has a negative resistance temperature characteristic which uses barium titanate as the main ingredients, Said fixed-resistance ceramic device consists of a ceramic resistor which uses barium titanate as the main ingredients, Said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device consists of a lamination ceramic body by which laminate integration was carried out, In a field of said PTC ceramic device, the 1st side of said lamination ceramic body, An internal electrode connected to exterior electrodes formed in the 2nd side is formed, respectively, and an internal electrode connected to exterior electrodes formed in said 2nd side of said lamination ceramic body is formed in a field of said NTC ceramic device or said fixed-resistance ceramic device, Between a field of said NTC ceramic device or said fixed-resistance ceramic device, or said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device, An internal electrode connected to exterior electrodes formed in the 3rd side of said lamination ceramic body is formed, Exterior electrodes formed in said 2nd side of said lamination ceramic body are the lamination compound ceramic devices which are a bipolar electrode of a series connection circuit with said PTC ceramic device, said NTC ceramic device, or said fixed-resistance ceramic device.

[0017]An invention concerning claim 9 is a lamination compound ceramic device to which a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device sets a mole ratio (Ba/Ti) of barium and titanium to 0.99-1.05.

[0018]An invention concerning claim 10 is a lamination compound ceramic device by which a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said PTC ceramic device is replaced with calcium in 5-25-mol% of barium.

[0019]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device an invention concerning claim 11, It is a lamination compound ceramic device which sets a mole ratio (Ba/Ti) of barium and titanium to 0.95-1.01.

[0020]A ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or said fixed-resistance ceramic device an invention concerning claim 12, converting manganese oxide into manganese -- 0.01-1-mol % -- it is the contained lamination compound ceramic device.

[0021]A ceramic semiconductor which has a positive resistance temperature characteristic to which an invention concerning claim 13 uses as the main ingredients barium titanate which constitutes said PTC ceramic device, Or a ceramic semiconductor which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes said NTC ceramic device, or a ceramic resistor which uses as the main ingredients barium titanate which constitutes said fixed-resistance ceramic device -- SiO 20.05-5-mol % -- it is the contained lamination compound ceramic device.

[0022]A reason which limited barium of a ceramic semiconductor and a mole ratio (Ba/Ti) of titanium which have a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes a PTC ceramic device to 0.99-1.05, It is because it becomes an NTC characteristic, room temperature resistance becomes high too much or more by 1.05 and an output control becomes insufficient by less than 0.99.
[0023]A reason which limited content of calcium of a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes a PTC ceramic device to 5-25-mol%, If less than [ 5 mol % ] does not show a PTC characteristic but 25-mol % is exceeded, in order to high-resistance-ize, it is because an output control becomes impossible enough.
[0024]Furthermore, A NTC ceramic device. Barium titanate to constitute. A reason which limited barium of a ceramic resistor and a mole ratio (Ba/Ti) of titanium which use as the main ingredients barium titanate which constitutes a ceramic semiconductor which has a negative resistance temperature characteristic used as the main ingredients, or said fixed-resistance ceramic device to 0.95-1.03, It is high resistance in less than 0.95, and is because it will become difficult to be possible [ an output control ] since it becomes a PTC characteristic if 1.03 is exceeded.
[0025]A reason which converted into manganese manganese oxide of a ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes a PTC ceramic device, and was limited to 0.01-1-mol%, It is for high-resistance-izing less than [ 0.01 mol % ], if there is no prominent effect and 1-mol % is exceeded, since the PTC characteristic is small.
[0026]A ceramic semiconductor which has a positive resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes a PTC ceramic device, A reason which limited SiO2 content of a ceramic resistor which uses as the main ingredients barium titanate which constitutes a ceramic semiconductor or a fixed-resistance ceramic device which has a negative resistance temperature characteristic which uses as the main ingredients barium titanate which constitutes a NTC ceramic device to 0.05-5-mol%, It is to high-resistance-ize and for many defects, such as peeling, to also generate a mechanical strength weakly moreover less than [ 0.05 mol % ], less than [ 0.05 mol % ], if there is no prominent effect and 5-mol % is exceeded, since the PTC characteristic is small.
[0027]
[Embodiment of the Invention]The structure of a lamination compound ceramic device using the lamination compound ceramics obtained by this invention is explained. Drawing 1 is a figure showing the lamination compound ceramic device of the 1st example, (a) is a perspective view and (b) is a sectional view in an A-A line. The semiconductor ceramic element or the fixed-resistance ceramic device (henceforth a NTC-R ceramic device) 1 in which the lamination compound ceramic device 4 has a negative resistance temperature characteristic, The semiconductor ceramic element (henceforth a PTC ceramic device) 2 which has a positive resistance temperature characteristic, It consists of the internal electrode 3, the 1st exterior electrodes 5 for PTC ceramic devices, the 2nd exterior electrodes 6 for NTC-R ceramic devices, and the 3rd exterior electrodes

7 electrically connected with the internal electrode 3.
[0028]One end is pulled out by the front face of the drawing upper load layer compound ceramic device 4, and is electrically connected with the 3rd exterior electrodes 7, and, as for the other end, the internal electrode 3 is laid underground in lamination compound ceramic device 4 main part. The 1st exterior electrodes 5 are formed in the field in which the 3rd exterior electrodes 7 were formed, and the field of two ******, and are connected with the PTC ceramic device 2. The 2nd exterior electrodes 6 are formed in two fields which counter with the 1st exterior electrodes 5, and are connected with the NTC-R ceramic device 1.
[0029]The NTC-R ceramic device 1 and the PTC ceramic device 2 consist of ceramics which use barium titanate as the main ingredients, the internal electrode 3 uses nickel as the main ingredients, and the 1st exterior electrodes 5, 2nd exterior electrodes 6, and 3rd exterior electrodes 7 use silver as the main ingredients.

[0030]This example is described based on the example using the ceramic green sheet which is uncalcinated ceramics. As a raw material, barium carbonate, calcium carbonate, titanium oxide, a lanthanum trioxide, Prepare manganese oxide and oxidized silicon and this General formula (1) (Ba0.797Ca0.20La0.003) 1.005TiO3+0.01SiO2+0.0005Mn, It prepares so that general formula [ (2) (Ba0.997La0.003) 0.995] TiO3+0.01SiO2 may become comparatively, With pure water and a zirconia ball, it put into the pot made from polyethylene, wet-blending grinding was carried out for 5 hours, and temporary quenching of this preparation raw material was carried out at 1100 ** after desiccation and among the air for 2 hours.
[0031]Water, the binder, and the dispersing agent were added into this temporary-quenching powder, wet-blending grinding was carried out with the zirconia ball for 12 hours, and it was considered as ceramic slurry. This ceramic slurry is fabricated to a ceramic green sheet with a doctor blade method. From a general formula (1), the NTC-R ceramic device 1 is obtained from the PTC ceramic device 2 and a general formula (2).
[0032]Drawing 2 is an exploded perspective view for explaining the manufacturing method of the lamination compound ceramic device 4, The ceramic green sheet used as the NTC-R ceramic device 1 obtained by the above-mentioned method. (It is hereafter called a NTC-R sheet) The ceramic green sheet used as 1a and the PTC ceramic device 2. (It is hereafter called a PTC sheet) preparing 2a -- the piece of the PTC sheet 2a -- the conductive pattern 3a used as the internal electrode 3 is screen-stenciled to the principal surface with the conductive paste which mixed the varnish with nickel powder. The NTC-R sheet 1a was laminated and stuck to the upper layer of the PTC sheet 2a in which this conductive pattern 3a is formed by pressure, and it was considered as the layered product.
[0033]Thus, after carrying out binder combustion of the obtained layered product in the atmosphere, among H2/N2 atmosphere, it calcinates at 1350 ** for 2 hours, and lamination compound ceramics are obtained. Silver paste was applied to the surface of the obtained lamination compound ceramics, among the atmosphere, it heat-treated for 1 hour and 800 ** of exterior electrodes 5, 6, and 7 were formed. Silver paste baking serves as reoxidation processing of lamination compound ceramics. Although two-layer [ of the PTC ceramic device 2 and the NTC-R ceramic device 1 ] was used in drawing 1, and the sheet, one sheet of the PTC sheet 2a and one sheet of the NTC-R sheet 1a, of two sheets was used in drawing 2 and explained, the number of laminations may be chosen according to the characteristic made profitably like.
[0034]Drawing 3 is a figure showing the lamination compound ceramic device of the 2nd example, (a) is a perspective view and (b) is a sectional view in a B-B line. The lamination compound ceramic device 41 The NTC-R ceramic device 11, The PTC ceramic device 21 is constituted by the lamination ceramic body by which laminate integration was carried out, the internal electrodes 31 and 32 are formed in the field of the NTC-R ceramic device 11, and the internal electrodes 33 and 34 are formed in the field of the PTC ceramic device 21.

[0035]The internal electrode 31 is pulled out among the internal electrodes 31-34 by the 3rd side 41c in which an end is equivalent to the front face of the drawing upper load layer compound ceramic device 41, It is electrically connected with the exterior electrodes 71 formed in this 3rd side 41c, and the other end is laid underground in lamination compound ceramic device 41 main part.

[0036]Next, the internal electrode 32 is formed in the field of the NTC-R ceramic device 11, That one end is pulled out by the 2nd side 41b of the lamination compound ceramic device 41, it is electrically connected with the exterior electrodes 61 formed in this 2nd side 41b, and the other end is laid underground in the field of the NTC-R ceramic device 11.
[0037]Furthermore, the internal electrodes 33 and 34 are formed in the field of the PTC ceramic device 21, Among these, that one end is pulled out by the 2nd side 41b of the lamination compound ceramic device 41, the internal electrode 33 is electrically connected with the exterior electrodes 61 formed in this 2nd side 41b, and the other end is laid under the field of the PTC ceramic device 21.

[0038]That one end is pulled out by the 1st side 41a of the lamination compound ceramic device 41, the internal electrode 34 is electrically connected with the exterior electrodes 51 formed in this 1st side 41a, and the other end is laid under the field of the PTC ceramic device 21. Here, the internal electrode 32 of the NTC-R ceramic device 11 and the internal electrode 33 of the PTC ceramic device 21 will electrically be mutually connected by the exterior electrodes 61.

[0039]Although the internal electrode 31 showed the example currently formed in the field of the NTC-R ceramic device 11, it may be formed between the NTC-R ceramic device 11 and the PTC ceramic device 21.
[0040]The NTC-R ceramic device 11 and the PTC ceramic device 21 consist of ceramics which use barium titanate as the main ingredients, The internal electrodes 31-34 use nickel as the main ingredients, and the exterior electrodes 51 formed in the 1st side 41a of the lamination compound ceramic device 41, the exterior electrodes 61 formed in the 2nd side 41b, and the exterior electrodes 71 formed in the 3rd side 41c use silver as the main ingredients.
[0041]Drawing 4 is an exploded perspective view for explaining the manufacturing method of the lamination compound ceramic device 41, and prepares the same material as the 1st example, the NTC-R sheets 11a-11d obtained with the same manufacturing method, and the PTC sheets 21a-21e.
[0042]the piece of the NTC-R sheet 11b -- the conductive pattern 31a used as the 1st internal electrode 31 to the principal surface, the piece of the NTC-R sheet 11d -- the conductive pattern 32a used as the 2nd internal electrode 32 to the principal surface, a PTC sheets [ 21b and 21d ] piece -- the conductive pattern 34a used as the conductive pattern 33a used as the 3rd internal electrode 33 and the 4th internal electrode 34 is screen-stenciled to the principal surface with the conductive paste which mixed the varnish with nickel powder. Said conductive patterns 31a, 32a, 33a, and 34a. The formed NTC-R sheets 11b and 11d, the PTC sheets 21b and 21d, the NTC-R sheets 11a and 11c in which a conductive pattern is not formed, and the PTC sheets 21a, 21c, and 21e in which a conductive pattern is not formed were laminated and stuck by pressure, and it was considered as the layered product.
[0043]Thus, after carrying out binder combustion of the obtained layered product in the atmosphere, among H2/N2 atmosphere, it calcinates at 1350 ** for 2 hours, and lamination compound ceramics are obtained. Silver paste was applied to the surface of the obtained lamination compound ceramics, among the atmosphere, it heat-treated for 1 hour and 800 ** of exterior electrodes 51, 61, and 71 were formed. Silver paste baking serves as reoxidation processing of lamination compound ceramics.
[0044]Laminating order may make laminating order reverse so that the PTC sheet 21e may become the top layer and the NTC-R sheet 11a may become the bottom of the heap besides having been shown in drawing 4. Although nine four-layer layers were

used in drawing 3, the PTC ceramic device 21 used the sheet of five sheets and four NTC-R sheets [ 11a-11d ] sheets of the PTC sheets 21a-21e in drawing 4 and five layers and a NTC-R ceramic device have explained, the number of laminations may be chosen according to the characteristic made profitably like. What is necessary is just to also choose arbitrarily the number of the internal electrodes 33 and 34 formed in the field of the PTC ceramic device 21.

[0045]Although the internal electrodes 31 and 32 formed in the field of the NTC-R ceramic device 11 are independently formed in the NTC-R ceramic sheets [ 11b and 11d ] sheet of two sheets, It may form in the shape for which lessons is taken from one one of NTC-R ceramic sheets [ 11b and 11d ] sheets and which is united with them.
[0046]the internal electrodes 31 and 32 make drawing 5 (a) and (b) associate -- as the example of shape -- the piece of the NTC-R ceramic sheet 11d -- it is a perspective view in which the conductive patterns 31a and 32a were formed to the principal surface. The internal electrode 31 is electrically connected with the exterior electrodes 71 in which one end was formed in the 3rd side 41c in which it hits the front face of the drawing upper load layer compound ceramic device 41, and the other end is laid underground in lamination compound ceramic device 41 main part. One end is pulled out by the 2nd side of the drawing upper load layer compound ceramics 41 at 41b, the internal electrode 32 is electrically connected with the exterior electrodes 61 formed in this 2nd side 41b, and the other end is laid underground in lamination compound ceramic 41 main part. The other ends of the internal electrodes 31 and 32 laid underground into lamination compound ceramic device 41 main part are formed so that it may not touch or cross. It may be made to associate, and as long as shape agrees not only on (a) of drawing 5, and (b) but on the above-mentioned conditions, what kind of shape may be sufficient as it.
[0047]That by which a conductive pattern is equivalent to the internal electrodes 33 and 34 to the field of the NTC-R ceramic device 11 in that by which a conductive pattern is equivalent to the internal electrodes 31 and 32 may be formed in the field of the PTC ceramic device 21. According to such an example, 41b becomes the 1st side among [ 41c ] the lamination compound ceramic devices 41, and becomes the 2nd side, 41a becomes the 3rd side, and the electrodes 71, 61, and 51 are formed in each side.
[0048]Voltage division of the input voltage (Vin) was carried out by the PTC ceramic device 21 and the NTC-R ceramic device 11 using the lamination compound ceramic device 41 obtained in the 2nd example, the circuit of drawing 6 which outputs output voltage (Vout) was constituted, and the curve which shows the output ratio-temperature characteristics of drawing 7 was obtained. Vertical axes are [ an output ratio and the horizontal axis of drawing 7 ] temperature (**). With an output ratio, an output voltage value (Vout) is **(ed) with the output voltage value (Vout-25) of 25 **. The output ratio is going up quickly with a certain temperature, and the lamination compound ceramic device 41 of this invention is understood that overheat detection of a transistor is possible as shown in drawing 7.
[0049]Next, the lamination compound ceramic device from which a presentation differs the PTC ceramic device of the lamination compound ceramic devices 4 and 41, a NTC-R ceramic device, and a little is explained.
(a) Barium of a PTC ceramic device and the mole ratio (Ba/Ti) of titanium which were shown in the general formula (1) were changed at a rate shown in Table 1, and the lamination compound ceramic device was obtained by the same method as the 2nd example. By the obtained lamination compound ceramic device, the circuit of drawing 6 was constituted and room temperature resistance (omega) of a PTC ceramic device, the characteristic of a PTC ceramic device, and an output ratio were measured. The result is shown in Table 1. This output ratio ** the output voltage value (Vout-150) of 150 ** with the output voltage value (Vout-100) of 100 **.
[0050]If the mole ratio of Ba/Ti is within the limits of 0.99-1.05, it turns out

that sufficient output control is possible. In the mole ratio of Ba/Ti, a PTC ceramic device serves as an NTC characteristic by less than 0.99, room temperature resistance becomes high too much or more by 1.05, and an output control is insufficient.

[0051]

[Table 1]

| Ba/Ti モル比 | ＰＴＣセラミック素子 | | 出力電圧比 |
|---|---|---|---|
| | 室温抵抗（Ω） | 特　性 | |
| 0.97 | 250 | ＮＴＣ | 1.5 |
| 0.99 | 320 | ＰＴＣ | 12 |
| 1.00 | 380 | ＰＴＣ | 150 |
| 1.01 | 520 | ＰＴＣ | 80 |
| 1.03 | 720 | ＰＴＣ | 63 |
| 1.05 | 950 | ＰＴＣ | 15 |
| 1.07 | 15000 | ＰＴＣ | 1.2 |

[0052](b) Barium of a PTC ceramic device and the ratio of calcium which were shown in the general formula (1) were made into the rate shown in Table 2, and the lamination compound ceramic device was obtained by the same method as the 2nd example. By the obtained lamination compound ceramic device, the circuit of drawing 6 was constituted and room temperature resistance of a PTC ceramic device, the characteristic of a PTC ceramic device, and an output ratio were measured. The result is shown in Table 2. This output ratio is the same as what was indicated by the above-mentioned paragraph of (a).

[0053]It turns out that output control sufficient by carrying out the amount of substitution of calcium 5-25-mol% of within the limits is possible. If the amount of substitution of calcium does not show a PTC characteristic by less than [ 5 mol % ] but exceeds 25-mol %, in order to high-resistance-ize, an output control becomes impossible enough.

[0054]

[Table 2]

| Ca含有量（モル%） | ＰＴＣセラミック素子 | | 出力電圧比 |
|---|---|---|---|
| | 室温抵抗（Ω） | 特　性 | |
| 0 | 50 | ＮＴＣ | 1.2 |
| 3 | 150 | ＰＴＣ | 2.8 |
| 5 | 250 | ＰＴＣ | 25 |
| 10 | 350 | ＰＴＣ | 35 |
| 20 | 380 | ＰＴＣ | 160 |
| 25 | 580 | ＰＴＣ | 35 |
| 30 | 13000 | ＰＴＣ | 1.8 |

[0055](c) Barium of a NTC-R ceramic device and the mole ratio (Ba/Ti) of titanium which were shown in the general formula (2) were changed at a rate shown in Table 3, and the lamination compound ceramic device was obtained by the same method as the 2nd example. By the obtained lamination compound ceramic device, the circuit of drawing 6 was constituted and room temperature resistance of a NTC-R ceramic device, the characteristic of a NTC-R ceramic device, and an output ratio were measured. The result is shown in Table 3. This output ratio is the same as what was indicated by the above-mentioned paragraph of (a). - seal shown in the column of the characteristic in front shows that a NTC-R ceramic device did not show an NTC characteristic.

[0056]It turns out that output control sufficient by carrying out the mole ratio of Ba/Ti within the limits of 0.95-1.01 is possible. The mole ratio of Ba/Ti is high resistance in less than 0.95, and since it will become a PTC characteristic if 1.03 is exceeded, it becomes difficult to be possible [ an output control ].

[0057]
[Table 3]

| Ba/Tiモル比 | ＮＴＣ－Ｒセラミック素子 | | 出力電圧比 |
|---|---|---|---|
| | 室温抵抗（Ω） | 特　性 | |
| 0.93 | 1500 | ＮＴＣ | 1.2 |
| 0.95 | 850 | ＮＴＣ | 12 |
| 0.97 | 380 | ＮＴＣ | 25 |
| 0.99 | 250 | ＮＴＣ | 160 |
| 1.01 | 450 | － | 85 |
| 1.03 | 15000 | ＮＴＣ | 5.5 |

[0058](d) It was made to contain at a rate which converts manganese oxide into the PTC ceramic device shown in the general formula (1) at manganese, and is shown in Table 4, and the lamination compound ceramic device was obtained by the same method as the 2nd example. By the obtained lamination compound ceramic device, the circuit of drawing 6 was constituted and room temperature resistance of a PTC ceramic device, the characteristic of a PTC ceramic device, and an output ratio were measured. The result is shown in Table 4. This output ratio is the same as what was indicated by the above-mentioned paragraph of (a).

[0059]It turns out that output control sufficient by carrying out content of manganese 0.01-1-mol% of within the limits is possible. Since the PTC characteristic is small less than [ 0.01 mol % ], if the content of manganese does not have a prominent effect and exceeds 1-mol %, it will high-resistance-ize.
[0060]
[Table 4]

| Mn含有量（モル%） | ＰＴＣセラミック素子 | | 出力電圧比 |
|---|---|---|---|
| | 室温抵抗（Ω） | 特　性 | |
| 0 | 50 | ＰＴＣ | 3.5 |
| 0.005 | 150 | ＰＴＣ | 8.2 |
| 0.01 | 250 | ＰＴＣ | 19 |
| 0.05 | 380 | ＰＴＣ | 180 |
| 0.1 | 400 | ＰＴＣ | 230 |
| 0.5 | 580 | ＰＴＣ | 110 |
| 1 | 890 | ＰＴＣ | 35 |
| 2 | 250000 | ＰＴＣ | 1.2 |

[0061](e) The PTC ceramic device shown in the general formula (1) and the NTC-R ceramic device shown in the general formula (2) were made to contain SiO2 at a rate shown in Table 5, and the lamination compound ceramic device was obtained by the same method as the 2nd example. By the obtained lamination compound ceramic device, the circuit of drawing 6 was constituted and room temperature resistance of a PTC ceramic device, room temperature resistance of a NTC-R ceramic device, and an output ratio were measured. The result is shown in Table 5. An output

ratio is the same as what was indicated by the above-mentioned paragraph of (a).

[0062]It turns out that output control sufficient by carrying out SiO2 content 0.05-5-mol% of within the limits is possible. Since the PTC characteristic is small less than [ 0.05 mol % ], if SiO2 content does not have a prominent effect and exceeds 5-mol %, it will high-resistance-ize. Less than [ 0.05 mol % ], a mechanical strength is also weak and many defects, such as peeling, occur.

[0063]
[Table 5]

| $SiO_2$含有量 (モル%) | PTCセラミック素子 | NTC-Rセラミック素子 | 出力電圧比 |
|---|---|---|---|
| | 室温 | 抵抗（Ω） | |
| 0 | 890 | 600 | 2.1 |
| 0.01 | 780 | 580 | 3.5 |
| 0.05 | 450 | 450 | 12 |
| 0.1 | 400 | 320 | 58 |
| 0.5 | 350 | 280 | 120 |
| 1 | 280 | 300 | 150 |
| 5 | 520 | 460 | 130 |
| 10 | 15000 | 2300 | 8.2 |

[0064]Although the above mainly explained the example of temperature detection, Strontium replaces barium of a PTC ceramic device 20%, General formula (Ba0.597Sr0.20Ca0.20La0.003) It prepared in proportion shown from 1.005TiO3+0.01SiO2+0.0005Mn, and the lamination compound ceramic device was obtained by the same method as the 2nd example. The circuit of drawing 6 was constituted from an obtained lamination compound ceramic device, and the straight line which shows the output ratio-temperature characteristics of drawing 8 was obtained. Vertical axes are [ an output ratio and the horizontal axis of drawing 8 ] temperature (**). This output ratio is the same as what was indicated in the 2nd example. Since the output is changing from the room temperature gradually as shown in drawing 8, the characteristic for temperature compensating can be shown and it can use as an object for temperature compensating.

---

DESCRIPTION OF DRAWINGS

---

[Brief Description of the Drawings]
[Drawing 1]It is a figure showing the lamination compound ceramic device of the 1st example of this invention, and is a sectional view [ in / (a) can be set in a perspective view and / in (b) / the A-A line of (a) ].
[Drawing 2]It is an exploded perspective view for explaining the manufacturing method of the lamination compound ceramic device of the 1st example of this invention.
[Drawing 3]It is a figure showing the lamination compound ceramic device of the 2nd example of this invention, and is a sectional view [ in / (a) can be set in a perspective view and / in (b) / the B-B line of (a) ].
[Drawing 4]It is an exploded perspective view for explaining the manufacturing method of the lamination compound ceramic device of the 2nd example of this invention.
[Drawing 5]It is a perspective view of the ceramic sheet of an internal electrode in which it is made to associate and the example of shape is shown.
[Drawing 6]It is the circuit diagram used in the example of this invention.

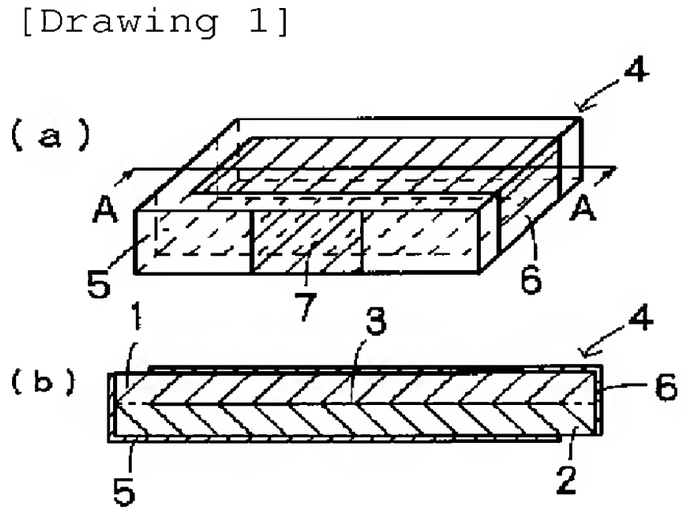
[Drawing 7]It is a characteristic figure showing the temperature and the output ratio of a lamination compound ceramic device of this invention.
[Drawing 8]It is a characteristic figure showing the temperature and the output ratio of a lamination compound ceramic device of this invention.
[Description of Notations]
1 NTC-R ceramic device
1a NTC-R sheet
2 PTC ceramic device
2a PTC sheet
3 Internal electrode
3a Conductive pattern
4 Lamination compound ceramic device
5 The 1st exterior electrodes
6 The 2nd exterior electrodes
7 The 3rd exterior electrodes
11 NTC-R ceramic device
11a, 11b, 11c, an 11d NTC-R sheet
21 PTC ceramic device
21a, 21b, 21c, 21d, 21e PTC sheet
31, 32, 33, and 34 Internal electrode
31a, 32a, 33a, 34a conductive pattern
41 Lamination compound ceramic device
51 Exterior electrodes formed in the 1st side
61 Exterior electrodes formed in the 2nd side
71 Exterior electrodes formed in the 3rd side

---

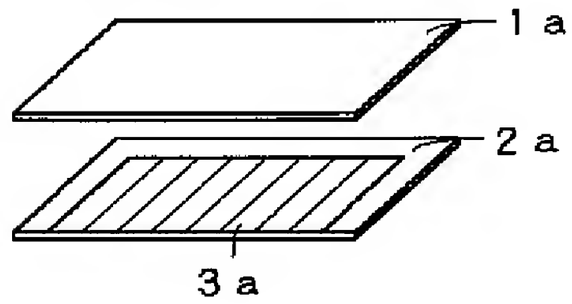
DRAWINGS

---

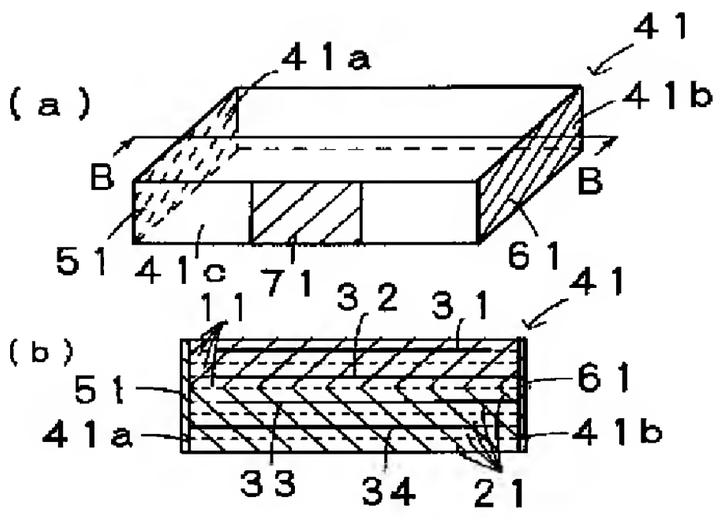
[Drawing 1]



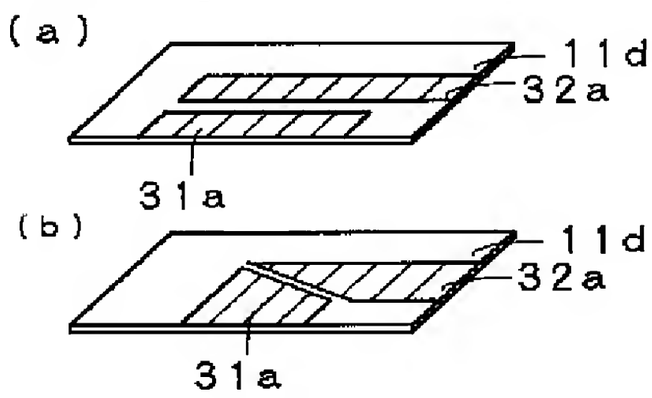

[Drawing 2]



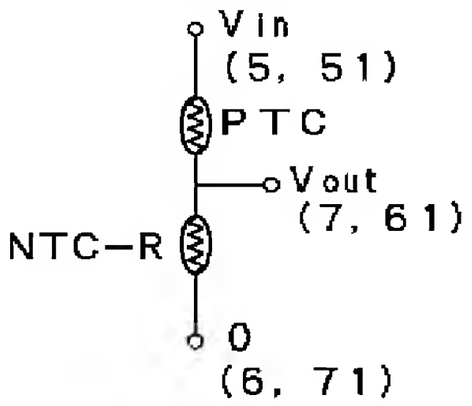

[Drawing 3]



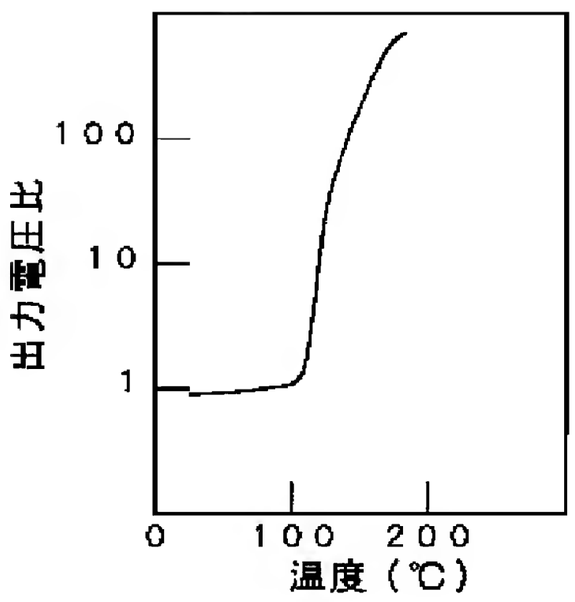

[Drawing 5]



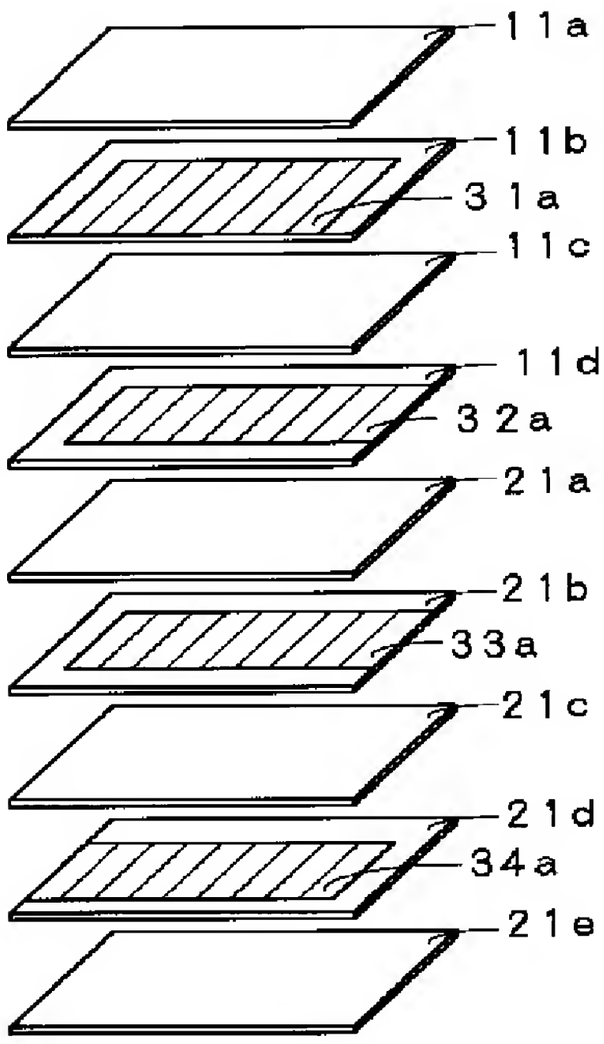

[Drawing 6]



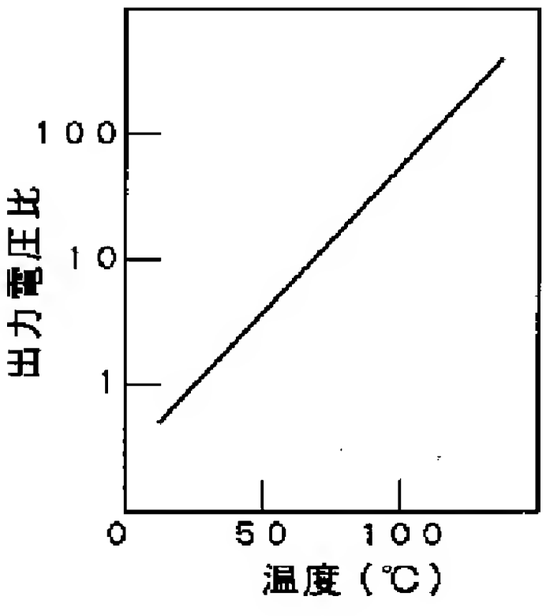

[Drawing 7]




[Drawing 4]


11a
11b
31a
11c
11d
32a
21a
21b
33a
21c
21d
34a
21e

[Drawing 8]


100
10
1
出力電圧比
0
50
100
温度（℃）